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Review Article

Waist-To-Height Ratio as a Screening Tool for Childhood Obesity: A Systematic Literature Review

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Keywords

- Waist-to-height ratio
- Children
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Abstract

Background: Childhood obesity is growing worldwide and brings concerns that overweight or obese children are more likely to become obese as adults. Early diagnosis is of utmost importance, and for that purpose, WHtR is easy to use and interpret by the primary care physicians.

Objective: To examine the validity of the waist-to-height ratio as a tool for obesity screening in the pediatric population.

Data sources: The search for articles was conducted in the following databases: Medline (via PubMed), Scientific Electronic Library Online (SciELO), CAPES Bank of Theses and Dissertations, and Cochrane Library.

Study selection: The authors independently selected the studies in two steps, first by assessing the title and abstract, and then by reading the full text. Disagreements were resolved through consensus.

Data extraction: The data were summarized in a table covering the study site, year of publication, mean age and standard deviation, total sample size and percentage of boys, cutoff points and gender-related sensitivity and specificity, and risk of bias.

Results: The weighted average cutoff points of the examined studies were 0.459 (± 0.017) for girls and 0.473 (± 0.019) for boys, in the 6–18 year age group.

Limitations: There was one study from a single country responsible for the largest number of samples, which might have affected the results because of ethnic factors.

Conclusions: The WHtR cutoff point for children and adolescents aged 6 to 18 years should be lower than that determined for adults. Studies involving children from several countries are still needed to validate the appropriate cutoff point for childhood obesity diagnosis.

ABBREVIATIONS

WHtR: Waist-to-Height Ratio; BMI: Body Mass Index

INTRODUCTION

Child obesity has become a worldwide public health problem, since obese children tend to become obese adults, which is known to be a risk factor for cardiovascular disease [1]. Early and correct detection of childhood obesity depends on multiple measures, because, separately, they can leave gaps and determine false negatives [2].

The most commonly used criterion for the diagnosis of overweight and obese children is based on BMI, adapted to their age and gender. The World Health Organization (WHO) standard curves are used, which characterize overweight children with a BMI that is higher than the z +1 score on the curve, and who are obese if the BMI is higher than the Z +2 score on the BMI curve for age, adjusted for gender [3,4].

Additional measures have been used for the diagnosis of childhood obesity. Studies in several countries have developed waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) curves as an additional tool or alternative screening for obesity in this age group [5-11]. All studies emphasize the need for curves to encompass children from all over the world and establish cutoff points for these measures.

WHtR was initially used in the 1990s with the aim of assessing abdominal fat in adults and possible cardiovascular risk [12]. It has the advantage of being easily performed and, in most studies, having little age- and gender-related variations, which could make this measure more universal than the BMI [6,13,14]. The cutoff point of 0.5 established for adults has been used in the pediatric age group as well. However, obesity may be underestimated in some populations [7], which makes it necessary to evaluate this cutoff point for children, so that it can be useful in the diagnosis of childhood obesity [15].

Given the growing concern about the increase in obesity, it is important to evaluate the diagnostic criteria for childhood obesity, in order to facilitate assessment and screening of children at risk. The aim of this article was to determine the validity of the waist-to-height ratio as a screening tool for obesity in the pediatric age range.

This systematic review protocol adheres to the Preferred Reporting Items for Systematic Review and Meta-Analysis [16] and was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (registration number CRD42016042054).

Computerized searches were conducted in December 2016 for articles related to waist-to-height ratio and childhood obesity in the following databases: Medline (via PubMed), Scopus, Scientific Electronic Library Online (SciELO), CAPES Bank of Theses and Dissertations, and Cochrane Library. No date or publication status limits were applied, and articles published in English, Portuguese, or Spanish were included. In addition, the lists of relevant bibliographies were examined in order to identify those potentially eligible.

The search strategy for Medline (via PubMed) was as follows: (“waist-height ratio”[MeSH Terms] OR (“waist-height”[All Fields] AND “ratio”[All Fields]) OR “waist-height ratio”[All Fields] OR (“waist”[All Fields] AND “height”[All Fields] AND “ratio”[All Fields]) OR “waist to height ratio”[All Fields]) AND (“child”[MeSH Terms] OR “child”[All Fields] OR “children”[All Fields]) AND bmi [All Fields] AND (“child”[MeSH Terms] OR “child”[All Fields] OR “children”[All Fields]) AND (“obesity” [MeSH Terms] OR “obesity”[All Fields]). This strategy was adapted to the other databases as needed.

Cross-sectional or longitudinal studies comparing BMI and WHtR for the diagnosis of obesity among children and adolescents aged 3 to 18 years were considered eligible. In order to be included, the studies needed to meet the following criteria: to establish the diagnosis of obesity and/or overweight using BMI and to compare, through ROC curves, sensitivity and specificity to WHtR in relation to BMI, establishing a gender-related cutoff point. Articles that did not compare WHtR with BMI and those in which WHtR was not used to diagnose obesity but to assess cardiovascular risk were excluded.

According to the eligibility criteria, the authors independently selected the studies in two steps, first by assessing the title and abstract, and then by reading the full text. Disagreements were resolved through consensus.

A spreadsheet was prepared for the data extraction in which information related to the authors, year of data collection, study site, age group, sample size, WHtR cutoff point by gender, and sensitivity and specificity were recorded. We contacted the authors of those articles that did not present all the information, and excluded them if the inquiry was not answered.

The quality of articles was assessed by using the Quality Assessment of Diagnostic Accuracy Studies 2 (Quadas 2) [17], which is structured in four key domains representing the main sources of bias. The risk of bias was categorized as low, high, or unclear. Quality assessment was not used as a criterion for exclusion of articles, but rather as a parameter for comparison between the studies.

The main measurement was the cutoff point for boys and girls that corresponded to obesity, using the body mass index as the reference standard. The weighted average cutoff points of the selected review studies were calculated. The data were summarized in a table covering the study site, year of publication, mean age and standard deviation, total sample size and percentage of boys, cut-off points and gender-related sensitivity and specificity, and risk of bias.

Figure (1) presents the flowchart showing the article selection process. In the initial search, 707 articles were identified, 20 of which were removed for duplicity. Of the remainder, 648 were removed after title and abstract scrutiny, resulting in 39 articles for full reading. Of them, 32 were removed because they did not use BMI or WHtR for obesity diagnosis, but for cardiovascular risk assessment. At the end of the selection process, seven articles were eligible for analysis and were included in the review.

In all studies, a WHtR cutoff point for boys and girls was proposed, the age ranged from 6 to 18 years and included eutrophic, obese and overweighed children. The characteristics of the articles can be seen in Table (1).

Two studies conducted in China covered the largest number of children and adolescents of the revised articles, totaling 21,101 subjects. In one of these studies, the cutoff point was 0.45 for girls and 0.47 for boys [18], whereas as in the other study, the cutoff point was 0.475 and 0.485, respectively8. In both, the area under the ROC curve was higher at the cutoff point for boys.

Two studies, one in Greece [5] and one in Japan [9], established the value 0.5 as the best value for WHtR cutoff point. These two studies totaled 2,032 children (mean age 14 and 10 years, respectively). The study conducted in Greece had the highest mean age among the surveyed participants.

In Brazil, the study conducted by Ribeiro [19] had a sample with the lowest mean age and lowest WHtR value (0.45 for girls and 0.46 for boys). The mean age in this study was 8.6 years, and the sample was composed of 2,226 children. The study conducted in France also had a low mean age (9.6 years), but the cutoff values were slightly higher (0.49 for girls and 0.47 for boys). However, the sample was composed of only 122 subjects.

Taking all studies into account, 25,872 children from different countries had an ideal cutoff of less than 0.5. Two studies with samples totaling 2,032 children had an ideal cutoff point of 0.5 to diagnose obesity. The weighted average cutoff points of the examined studies were 0.459 (± 0.017) for girls and 0.473 (± 0.019) for boys, in the 6–18 year age group.

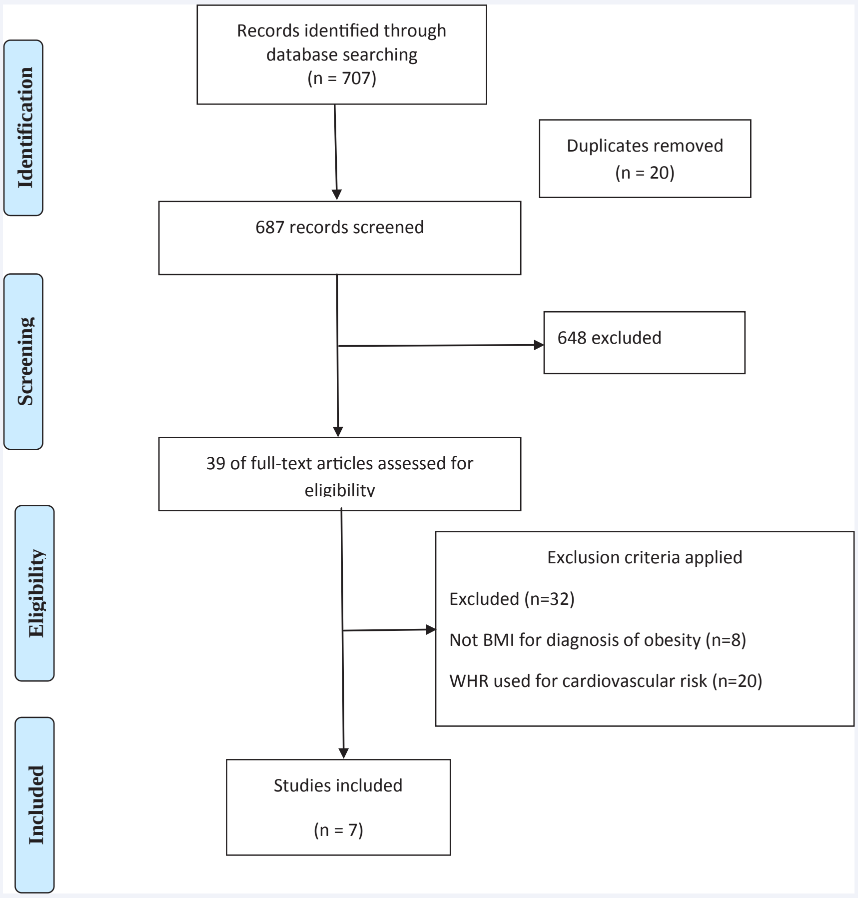

Figure 1 Flowchart showing the article selection process.

Table 1: Study characteristics.

Study	Study site	Year	Mean age (years) and standard deviation	Total (%boys)	Cutoff point for girls (S*;E**)	Cutoff point for boys (S*;E**)	QUADAS 2 (Risk of bias)
Bacopoulou [5]	Three municipalities in the Attic region (Greece), random selection of 23 schools, consecutive sample.	2015	14.4±1.7	1,610 (42.1)	0.5 (0.91;0.95)	0.5 (091;0.95)	Low risk
Rerksuppahol [27]	Random selection of 17 elementary schools in Nakorn, Thailand. Consecutive sample.	2013	9.9±2.6	1,877 (51.3)	0.467 (0.93;0.90)	0.467 (0.93;0.90)	Low risk
Fujita [9]	Two schools in Tokyo, in the years 2010 and 2009, consecutive sample.	2011	10	422 (53.5)	0.5 (1.0;0.95)	0.51 (1.0;0.95)	High risk
Weili [8]	Two ethnic groups that correspond to 90% of the population of Uygur and Han, China. Random sampling of schools.	2007	12.6±3.3	4,187 (47.2)	0.475 (0.9;0.9)	0.485 (0.96;0.93)	Low risk

Hubert [29]	Random selection of 5 classes from 2 primary schools in Lille, France.	2009	9.6±1.1	122 (53.2)	0.49 (1.0;0.87)	0.47 (0.86;0.87)	High risk
Zhou [18]	Six representative geographical areas of China. Consecutive sample of children, random selection of schools.	2014	11.7±2.6	16,914 (52.2)	0.45 (0.96;0.91)	0.47 (0.93;0.89)	Low risk
Ribeiro [19]	Probabilistic sample of five schools in southern Brazil.	2014	8.6±1.1	2,772 (51.6)	0.45 (0.89;0.86)	0.46 (0.86;0.91)	Low risk
*Sensitivity; **Specificity							

DISCUSSION AND CONCLUSION

Childhood obesity has reached troubling levels in Brazil, as well as in the world [20,21]. Moreover, it may be a presage of an obese adult population [22]. Taking action for the early diagnosis of childhood obesity is of paramount importance. The adoption of therapeutic and prophylactic measures will have an impact on obesity morbidity in the adult population [23]. Facilitating diagnosis of childhood obesity may help health professionals, who have great contact with the general population, and bring countless benefits for this disease management [2].

BMI is accepted by WHO as a standard measure for the diagnosis of overweight and obese children [3]. The use of BMI curves is a routine procedure for pediatricians who accompany children on a day-to-day basis. However, in the primary health care for the population, these curves are not always readily available, which requires other measures with comparable diagnostic power [9].

In the adult population, WHtR is related to cardiovascular risk and the recommendation for keeping it below 0.5 has been used as a mass prevention measure [24]. Although the suggested cutoff point for children is equal to that of adults in some studies [6,14,25-28], evidence suggests that this value may not be adequate, and there is the need to increase its sensitivity to become a good screening tool for childhood obesity [29,30].

The largest study was conducted in China and evaluated 16,914 children aged 9 to 16 years. The value determined by the authors as having the largest area under the curve was 0.45 for girls and 0.47 for boys, revealing a difference in the previously considered ideal, which was 0.518. Although small, this reduction increases the score sensitivity and reduces the rate of false negatives, which would allow the children to be referred for proper evaluation and confirmation of their nutritional status using the WHO curves, when taken as a screening method.

Two of the selected studies presented the following high risks of bias: (a) the schools were not randomly selected [9]; (b) they did not adequately represent the studied population [29]. The sample of these two studies represented a small portion of the total sample, and the cutoff point values in both were higher than those of the other studies included in this review. Furthermore, one of them had the highest mean age among all the included studies.

Studies carried out in several countries have developed WHtR values and age- and gender-specific curves in the pediatric range [6,7,13,31]. In all of them, it is evident that the WHtR value decreases with age, denoting that using the same values as those for adults may determine a large number of false negatives. The great advantage of using this measure is its ease of use: whereas BMI requires curves for interpretation [32], WHtR could establish a universal gender-specific value in the pediatric range and still maintain good sensitivity for childhood obesity screening [33].

WHtR may also serve as a cardiovascular risk predictor in obese individuals, since isolated elevation may indicate an increased risk of metabolic syndrome in childhood [15,34]. In two of the reviewed articles, WHtR performed better than BMI for the association with cardiovascular risk, indicating that WHtR values higher than 0.5 are associated with the metabolic syndrome in childhood [35,36].

Ethnic factors may affect WHtR, which is why new population studies for the determination of specific cutoffs for children around the world are still needed. The largest study included in this review was conducted in China and the authors themselves consider that ethnic differences may modify the WHtR cutoff points [18]. This may be the major limitation of that study because the largest portion of the sample came from a single country, which could determine a population trend. However, in the pediatric range, such a characteristic may not yet be so manifest as it is in adults. Furthermore, the available data made it impossible to carry out a meta-analysis because of the lack of complete data in the studies.

Nagy and colleagues stablished percentile trend values for anthropometric data collecting data from IDEFICS Study. The IDEFICS included only eutrophic children and proposed percentile curves for many antropometric body composition indices in a large sample of European children from 2 to 11 years old (n=18724). In the 90th percentile of WHtR from 6, 10, 11 years old the values range from 0,48 to 0,47 in girls and 0,48 to 0,46 in boys, and the lower values were in older children [37].

The analysis of the studies allows us to conclude that the WHtR cutoff point for children and adolescent aged 6 to 18 years is 0.47 for boys and 0.46 for girls. There are no studies which meet inclusion criteria in children under 6 years old. This result can be used as a screening test for primary care physicians. Further population-based studies are needed to support these cutoff points.

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